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(54) Title: ULTRA-HIGH TEMPERATURE TREATMENT OF LOW-FAT FORMED MEAT PRODUCTS (57) Abstract A method is disclosed for preparing a surface-pasteurized, low-fat, formed meat product. The method comprises removing surface fat, bones, and gristle, and cutting the meat into pieces. The pieces are mechanically tenderized and then mixed with water, salt, and phosphate. The mixture is massaged at 0° to 15 °C so that fat is conducted out of the meat and deposited on the wall of the apparatus, and protein is exuded to form a sticky surface on the pieces of meat. The massaged meat is then formed into a selected shape and frozen. The shaped meat is subjected to portion control either before or after freezing. The portions are then partially thawed, and the partially thawed portions are surface-pasteurized at ultra-high temperature (UHT), e.g. 900-1200 °C, for a time sufficient to denature proteins, without burning, to a depth of up to about 2 mm. Grill markings are then placed on the meat. After UHT treatment the meat is refrozen, packaged in a modified atmosphere containing carbon dioxide and nitrogen gas, and stored frozen.		

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5 **ULTRA-HIGH TEMPERATURE TREATMENT OF LOW-FAT FORMED
 MEAT PRODUCTS**

Background of the Invention

 This invention relates to pasteurization of meat
10 and meat products by altering the character of the meat
 surface. More particularly, this invention relates to
 a method of combining ultra-high temperature
 pasteurization and a process of producing a formed meat
 product to produce a low-fat, raw meat product that can
15 be stored for an extended period. Only the surface or
 visible portion of the meat product is altered with the
 remainder of the tissue below about 2 mm remaining in
 its raw or unaltered state. The invention also relates
 to preparation of a low-fat formed meat product by
20 pasteurization of the meat surface by ultra-high
 temperature treatment combined with packaging in a
 modified atmosphere.

 Extending the storage life of meat and meat
 products has been a subject of mankind's ingenuity since
25 before recorded history. Many procedures have been
 developed, but they are all subject to certain
 limitations. Cooking, smoking, and curing all render
 meat less susceptible to spoilage, but the flavor of the
 meat is altered, sometimes drastically, and the meat is
30 still subject to eventual spoilage. Chemical additives
 may be effective preservatives, but commercial
 acceptance and regulatory approval have been limiting
 factors. Meat can be frozen and stored for extended
 periods of time without seriously affecting flavor or
35 palatability, but maintaining the meat in a frozen state
 is expensive.

 Methods of sterilizing meat and other animal
 tissues with high temperature treatment have been
 described previously. U.S. Patent No. 4,539,212 to
40 Hunter teaches a process for sterilizing low-acid food
 containing meat or textured vegetable protein by
 acidifying the food, heating at high temperature (104-
 137°C) for a short time (5-60 seconds), and packing with
 a hot-fill-and-hold procedure. U.S. Patent No.

5 4,572,839 to Guitteny et al. teaches a method of high
temperature sterilization of animal protein by grinding
the raw material to make a slurry, partially hydrolyzing
it, and heating a thin layer of the slurry to about 120-
150°C for about 3 seconds to 15 minutes. U.S. Patent
10 No. 4,675,202 to Wenger et al. discloses a method of
sterilizing a slurry containing egg yolks by acidifying
and then heating at temperatures between 128-155°C for
a period of 1-50 seconds. U.S. Patent No. 4,201,796 to
Harkins discloses a method of cooking meat by searing
15 the surface of a cut or patty of meat by brief exposure
to a blow torch pencil burner while leaving the inside
of the meat relatively raw, refrigerating or freezing
the meat, and cooking thoroughly in a microwave oven.
U.S. Patent No. 5,366,746 to Mendenhall discloses a
20 method of pasteurizing meat and meat products for
extended storage at refrigerated temperatures by
treating the meat at ultra-high temperature (UHT), e.g.
900° to 1200°C, for a time sufficient to denature
proteins, without burning, to a depth of up to about 2
25 mm.

Formed meat products are well known in the art.
For example, U.S. Patent No. 4,539,210 to O'Connell et
al. describes a process of making a structured meat
product that can resemble a natural cut of meat. The
30 product is made by removing fat, gristle, sinew, and
skin from large primal cuts of meat and then cutting the
meat into quarter-pound chunks. These meat chunks are
then tenderized by severing the connective tissue of the
meat. The tenderized chunks are then massaged under
35 reduced pressure with water and a water soluble salt
and/or phosphate so that a sticky protein exudate is
caused to come to the surface of the meat chunks. The
meat chunks are then extruded with a fat emulsion formed
from the fat trimmings of the primal cuts to produce the
40 structured meat product with a fat cap or rim. Other
patents that disclose similar products and processes

5 include U.S. Patent No. 4,975,294 to Cohen; U.S. Patent
No. 4,810,514 to Guenther; U.S. Patent No. 4,377,597 to
Shapiro et al.; U.S. Patent No. 4,264,633 to Bradshaw;
U.S. Patent No. 4,210,677 to Huffman; U.S. Patent No.
3,821,445 to Okamura et al.; U.S. Patent No. 3,679,434
10 to Bard et al.; and U.S. Patent No. 3,499,767 to
Schlamb.

In view of the foregoing, it will be appreciated
that providing a method of preparing a surface-
pasteurized, low-fat, formed meat product that can be
15 stored for an extended period would be a significant
advancement in the art.

Objects and Summary of the Invention

An object of the present invention is to provide a
20 method of producing a low-fat, formed meat product that
can be stored for an extended period.

Another object of the invention is to provide a
method of making a low-fat, formed meat product that can
be surface-pasteurized by exposure to ultra-high
25 temperature.

Still another object of the invention is to provide
a method of preparing a surface-pasteurized, low-fat,
formed meat product that has the appearance of cooked
meat, but is raw.

30 These and other objects can be accomplished by
providing a method of preparing a low-fat, formed meat
product comprising the steps of:

(a) mechanically tenderizing a plurality of pieces
of meat so that multiple incisions or channels extending
35 from the exterior surface to the interior are formed;

(b) adding salt, phosphate, and water to the
tenderized pieces of meat to form a mixture and
massaging the mixture in a tumbling apparatus at a
temperature in the range of about 0°C to about 15°C so
40 that fat is transported through the incisions or
channels and deposited on the wall of the apparatus and

5 so that protein is exuded to form an adhesive layer on the exterior surface of the pieces of meat; and

(c) forming the massaged pieces of meat together into a selected shape. Optionally, the massaged meat can be bonded to a bone while being formed into the selected shape. The fat content of the formed meat product can be reduced to below about 5% by weight by sufficient massaging of the meat-containing mixture, but a selected fat content can be obtained by adding fat particles before forming the massaged pieces of meat into the selected shape. Salt, phosphate, and water are added in amounts so that the formed meat product comprises in the range of about 0.3 to about 0.6% salt, about 0.10 to about 0.19% phosphate, and about 70% to about 80% water, and, preferably, the formed meat product comprises about 0.5% salt, about 0.15% phosphate, and about 75% water, wherein all percentages are by weight. A flavoring agent can also be added to the mixture. The formed meat can be surface-pasteurized by freezing the formed meat and subjecting the formed meat to portion control to result in frozen portions, partially thawing the frozen portions to a depth of about 1 mm, and treating the partially thawed portions at ultra-high temperature in the range of about 900°C and about 1200°C for a time sufficient to denature surface proteins, without burning, to a depth of not more than about 2 mm. This gives the raw formed meat product the appearance of a cooked meat. The surface-pasteurized formed meat product can then be packaged, optionally in a modified atmosphere under reduced pressure, and stored frozen.

A method of preparing a surface-pasteurized, low-fat, formed meat product that can be stored for an extended period of time comprises the steps of:

(a) mechanically tenderizing a plurality of pieces of meat so that multiple channels extending from the exterior surface to the interior are formed;

5 (b) adding salt, phosphate, and water to the tenderized pieces of meat to form a mixture and massaging the mixture in a tumbling apparatus at a temperature in the range of about 0°C to about 15°C so that fat is transported through the channels and
10 deposited on the wall of the apparatus and so that protein is exuded to form an adhesive layer on the exterior surface;

(c) forming the massaged pieces of meat into a selected shape;

15 (d) freezing the formed meat and subjecting the formed meat to portion control to result in frozen portions;

(e) partially thawing the frozen portions to a depth of about 1 mm and treating the partially thawed
20 portions at ultra-high temperature in the range of about 900°C and about 1200°C for a time sufficient to denature surface proteins, without burning, to a depth of not more than about 2 mm; and

(f) freezing the ultra-high-temperature-treated
25 portions and packaging them, optionally, in a modified atmosphere under reduced pressure.

Massaging the meat-containing mixture for a sufficient time reduces the fat content to below about 5% by weight, but fat particles can be mixed with the
30 massaged meat to obtain a selected fat content. Optionally, the massaged meat can be bonded to a bone. The salt, phosphate, and water are added in amounts so that the formed meat product comprises in the range of about 0.3 to about 0.6% salt, about 0.10 to about 0.19%
35 phosphate, and about 70% to about 80% water, and preferably, about 0.5% salt, about 0.15% phosphate, and about 75% water, wherein all percentages are by weight. A flavoring agent can also be added to the mixture. The modified atmosphere comprises in the range of about 80%
40 to about 100% carbon dioxide and about 0% to about 20% nitrogen gas. The packaging can be in a microwavable

5 film so that the meat product can be cooked in a microwave oven or by any other conventional method.

Detailed Description of the Invention

10 Before the present method of producing a surface-pasteurized, low-fat, formed meat product that can be stored for an extended period is disclosed and described, it is to be understood that this invention is not limited to the particular process steps and materials disclosed herein as such process steps and materials may vary somewhat. It is also to be understood that the terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting since the scope of the present invention will be limited only by the appended claims and equivalents thereof.

20 It must be noted that, as used in this specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the content clearly dictates otherwise. Thus, for example, reference to a "a flavoring agent" includes reference to a mixture of two or more of such flavoring agents, reference to "a salt" includes reference to a mixture of two or more of such salts, and reference to "a phosphate" includes reference to a mixture of two or more such phosphates.

25 In describing and claiming the present invention, the following terminology will be used in accordance with the definitions set out below.

30 As used herein, "meat" means those soft animal tissues that are suitable for use as food including, but not limited to beef, pork, lamb, poultry, and fish.

35 As used herein, "formed meat product," "formed meat," and similar terms mean a product prepared by pressing, bonding, extruding, or otherwise coupling chunks of meat into a selected shape, usually to resemble the shape of a natural cut of meat.

5 As used herein, "salt" means NaCl, KCl, MgCl₂, CaCl₂, or mixtures thereof, with NaCl, KCl, or mixtures thereof being preferred.

 As used herein, "phosphate" means sodium, potassium, or ammonium pyrophosphates; sodium, potassium, or ammonium polyphosphates; sodium, potassium, or ammonium tripolyphosphates; trisodium, tripotassium, or triammonium phosphates; sodium, potassium, or ammonium hexametaphosphates; sodium, potassium, or ammonium orthophosphates; other food grade phosphates; and mixtures thereof. Preferred phosphates are tetrasodium pyrophosphate, acid sodium pyrophosphate, and glassy sodium polyphosphate.

 As used herein, "ultra-high temperature" or "UHT" means temperatures in the range of about 900°C to about 1200°C.

 As used herein, "modified atmosphere" means an atmosphere, without oxygen gas, containing in the range of about 80% to about 100% carbon dioxide and in the range of about 0% to about 20% nitrogen gas.

 As used herein, "portion control" means producing serving-size portions of substantially identical size, shape, and weight.

 It is desirable to create formed meat that, when cooked, has a natural shape and texture or has a natural shape and texture of a cut of meat that is more expensive than the meat used to create the formed meat. Further, it is desirable to have a formed meat that, in addition to having a natural shape and texture, has a lower amount of fat than the meat used to create the formed meat.

 The process described herein is limited to imitating different cuts of meat from the same type of animal because the flavor of any given type of animal is unique. Within a given type of animal, the texture of different cuts of meat is very similar except for

5 tenderness. Thus, cheaper cuts of meat are tenderized to imitate higher priced cuts of meat.

10 Initially, external fat, bones, and gristle are cut and removed from the large primal cuts of meat, and the remaining lean meat is cut into pieces. The size of the pieces of meat is not critical, however, the larger the pieces are, the more natural will be the texture of the finished formed meat product. The maximum size of the pieces, though, is limited by the capacity of the mechanical tenderizer used in the next step of the process. Therefore, a preferred size of the pieces of meat is an average weight of about 100 grams and an average minimum thickness of about 2.5 centimeters. Variations from these sizes are considered within the scope of the invention inasmuch as a person skilled in the art could, as a matter of routine optimization, adjust the size of the meat pieces according to the equipment being used.

25 Each piece of meat is then mechanically tenderized, preferable with multi-blade tenderizing equipment, such as a "BERKEL 704 MULTIBLADE" (Berkel Corp., LaPorte, Indiana). This step comprises severing the scaffold network or lattice of connective tissue that supports the muscle cells. This scaffold network is broken by making numerous incisions into the pieces of meat with the blades of the tenderizing equipment. The blades make cuts deep into the meat and also abrade the surface thereof. The cuts or incisions form channels that extend from the surface into the interior of the meat. The temperature at which tenderization is conducted is not critical to the process, but is routinely done at about 4.4°C (40°F). The meat should not be ground because grinding breaks muscle fibers excessively, thus preventing attainment of a natural texture. At the end of this step, the pieces of meat comprise slackened muscle tissue on a multiply severed connective tissue supporting network. the slackened muscle tissue also

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5 containing channels extending from the surface of the meat into the interior thereof.

Next, the tenderized meat pieces are combined with enough salt, phosphate, and water so that the final formed meat product contains in the range of about 0.3
10 to about 0.6% salt, about 0.10 to about 0.19% phosphate, and about 70% to about 80% water, wherein all percentages are by weight. Preferably, the final formed meat product contains about 0.5% salt, about 0.15% phosphate, and about 75% by weight water.

15 Next, the mixture of meat, salt, phosphate, and water is massaged by tumbling for at least about 30 minutes in commercial tumbling equipment, such as a "ROSCHERMATIC" (Röscherwerke GMBH, Germany). Preferably, this massaging step is conducted in an
20 oxygen-free atmosphere. During this massaging step, the temperature of the meat-containing mixture and the walls of the tumbling equipment are maintained in the range of about 0°C to about 15°C (about 32°F to about 59°F). This temperature range and the tenderizing step are
25 critical for maximizing extraction of fat from the pieces of meat. The free water added to the pieces of meat in the previous step aids in transporting fat from the pieces of meat to the walls of the tumbling or massaging equipment, where the extracted fat solidifies
30 and is deposited. The fat exits the meat through the incisions or channels made during the tenderization step. Upon removing the massaged meat from the tumbling equipment, the fat deposited on the wall of the equipment is separated from the meat. This procedure
35 generally reduces the fat content of the meat, leaving the finished product with less than about 5% fat by weight.

Optionally, one or more flavoring agents can be blended into the mixture after massaging. Fat content
40 can also be adjusted to a selected level at this stage of the process. Fat contributes to texture and

5 juiciness of the meat, thus some consumers prefer a
higher level of fat than 5%. Fat is frozen and then
ground through a plate with 0.3 cm openings. After
grinding, the fat is refrozen and then chopped to an
10 average particle size of 2-3 mm. The chopped fat
particles are added to the massaged meat using a mixer-
blender, such as a "KOCH/FATOSA" (Koch, Kansas City,
Missouri). This allows the production of formed meat,
e.g. steaks, with a fat level at a selected level,
15 preferably between about 5 and about 20% by weight.
Preferably, if fat is added to the massaged meat, then
the amount of water added is reduced by a percentage
equal to the percentage by weight of added fat.

During the massaging step, the added salt and
phosphate facilitate solubilization of protein and
20 bonding of water to the protein so that protein is
exuded to the surface of the meat, creating an adhesive
surface on the pieces of meat. After the massaging step
is completed, during which the fat content of the meat
is reduced and the adhesive surface is produced, the
25 pieces of meat are then formed into a selected shape.
This step of forming the meat into a shaped product can
be by pressing the pieces together, bonding, extrusion,
or other methods that are known to persons skilled in
this art. During this step of the process, the adhesive
30 layers of the massaged meat cause the pieces of meat to
be coupled together by protein-protein bonding.

It is also within the scope of the invention to
form a meat product having a bone bonded to the meat
according to the method of Serial No. 08/213,950, filed
35 March 23, 1994, now U.S. Patent No. 5,387,424, hereby
incorporated by reference. Briefly, a bone is cut from
a piece of meat so that a thin layer of meat is left on
the bone. The bone is then soaked in an aqueous
solution of salt and phosphate so that proteins are
40 extruded to form an adhesive protein layer on the
surface of the thin layer of meat. Massaged meat,

5 prepared as described above, is then formed around the bone to achieve a selected shape. The same type of protein-to-protein bonds that hold the formed meat together also hold the formed meat to the thin layer of meat that is left on the bone, thus bonding the formed
10 meat to the bone.

After the meat is formed into an appropriate shape, such as the shape of a primal cut, the low-fat, formed meat is frozen. The temperature for freezing the formed meat is not critical, but is routinely done at between
15 about -10 and -40°C with a temperature of about -34.4°C (-30°F) being optimal or preferred. After freezing, serving-size portions of substantially identical size, shape, and weight can be cut from the frozen primal-shaped formed meat product, a step referred to as
20 portion control, and these frozen portions are partially thawed to a depth of about 1 mm. Portion control is routinely conducted at a non-critical temperature in the range of about -4.4°C to about -3.3°C (about 24° to about 26°F).

25 An alternative method of achieving portion control comprises forming the portions directly from the massaged meat. A commercially available machine, "FORMAX" (Mokena, Illinois), can be used for this purpose. The portions are formed at about 0.5°C (33°F)
30 and then frozen at about -10 to about -40°C. Before UHT treatment the portions are partially thawed to a depth of about 1 mm, as with portions cut from a primal-shaped formed meat.

The partially thawed portions of low-fat, formed
35 meat are then exposed to treatment with UHT. The specific method used for treating meat with UHT to obtain the results disclosed herein are described in U.S. Patent No. 5,366,746, hereby incorporated by reference. The method involves placing the partially
40 thawed portions in a closed heat source, e.g., an electric oven, maintained at a temperature in the range

5 of about 900°C and 1200°C for a time sufficient to
denature surface proteins up to a depth of not more than
about 2 mm, i.e. typically between about 5 and 60
seconds. The oven is heated to the selected
10 temperature, the partially thawed portions are placed on
a grill outside the oven, and then the oven is opened
and the meat and grill are placed in the oven for the
selected length of time. Then, the meat is removed from
the oven. The internal temperature of the meat never
15 exceeds about -17.8°C (0°F) during the UHT treatment.
The UHT-treated meat is then marked with grill marks,
refrozen, and packaged as will be described in more
detail below.

The acceptable temperature for UHT treatment is in
a range of about 900°C to about 1200°C with a range of
20 about 1000°C to about 1200°C being preferred and about
1100°C being most preferred. By use of the term "about"
is meant that some variation is possible inasmuch as it
is virtually impossible to maintain a constant
temperature without any fluctuation. Therefore
25 variations of from ±25°C from that stated are considered
acceptable. Exposure times of 5-60 seconds at these
temperatures produce a raw, low-fat, formed meat product
with an attractive appearance with a denaturation depth
of less than about 2 mm and preferably less than about
30 1 mm. Under these conditions, shrinkage and internal
temperature are kept within acceptable limits. Further,
UHT pasteurization of the surface of the meat destroys
vegetative pathogens and reduces spoilage microorganisms
to very low levels on the surface, as shown in U.S.
35 Patent No. 5,366,746.

Preferably, grill marks are placed on the meat
after UHT treatment by placing the UHT-treated meat
portions on a heated grill surface. These grill marks
give the meat an attractive grilled (cooked) appearance
40 even though the meat is still raw.

5 The next step in the instantly disclosed process
comprises packaging the ultra-high temperature treated
meat. Optionally, this packaging can be in a modified
atmosphere under reduced pressure. Heretofore, high
10 levels (80-100%) of carbon dioxide gas mixed with
nitrogen gas have not been used to package raw meat
because of the adverse effect of such gas on the color
of the meat. Unexpectedly, it has been discovered that
the color and flavor of UHT pasteurized meat remain
stable during storage in a carbon dioxide atmosphere, as
15 disclosed in copending Application Serial No.
08/316,033, filed September 30, 1994, hereby
incorporated by reference. Thus, the ultra-high
temperature treated meat can be packaged, optionally, in
a modified atmosphere containing in the range of about
20 80% to about 100% carbon dioxide. A preferred modified
atmosphere comprises about 80% carbon dioxide and about
20% nitrogen gas. This packaging step is done under
reduced pressure, referred to in the art as vacuum
packaging. The temperature of the vacuum packaging step
25 is not critical, but is routinely done between about 0°
and 10°C (32-50°F) and most preferably at about 4.4°C
(40°F). After vacuum packaging, the finished product is
stored frozen, such as between about -10° to -25°C (14
to -13°F) and usually at about -17.8°C (0°F). Packaging
30 in an oxygen-free atmosphere reduces oxidation of fat in
the meat, thus extending shelf life, reducing
development of off flavors, and maintaining the natural
color of the meat.

 The packaging material is preferably a film that is
35 tolerant of being subjected to microwave energy so that
preparation for cooking is minimized. A preferred
microwavable film is a "NYLON" film, but other films are
known and could be selected as a matter of routine by a
person skilled in the art without undue experimentation.
40 With a microwavable film, the preparation for cooking
can be as simple as puncturing the packaging material,

5 placing the product in a microwave oven, and heating until a safe internal cooked temperature of greater than 64°C is obtained. The UHT-treated, low-fat, formed meat product can also be cooked in a conventional oven or by other known methods.

10

Example

This example compares the water, protein, fat, ash, and caloric contents of 100 g portions of raw beef, pork, or lamb with 100 g portions of raw, formed meat product made from beef, pork, or lamb according to the procedure of the present invention.

15

Table		
	Mean Composition of 100 g Portions	
	Unprocessed	Formed
20 Water	60 g	76 g
Protein	17 g	16.5 g
Fat	22 g	5 g
Ash	1 g	2.5 g
25 Kcal	266	111

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As shown in the Table, the protein content of the formed meat product ("formed") remains virtually unchanged as compared to the unprocessed meat ("unprocessed"). The fat content and caloric content of the formed product, however, are significantly reduced. The amount of fat is reduced to about 5% by weight of the meat product, a reduction of about 77% in the total amount of fat as compared to the unprocessed meat. The caloric content of the formed meat product is reduced to 111 Kcal/100 g, a reduction of about 58% as compared to the unprocessed meat.

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5 Another unique advantage of this process is that it
produces a raw meat product that has the appearance of
a cooked meat, e.g. a grilled steak. Since the meat is
raw, subsequent cooking of the meat avoids the warmed-
over-flavor typical of cooked meat that is reheated.
10 Further, cooking of a meat product according to the
instant process does not require the attention of a chef
that cooking "unprocessed" meat requires, since the
final appearance of the surface of the meat has already
been determined in large part by the UHT treatment and
15 grill marking steps. For these reasons, this formed
meat product would be highly desirable in the food
service industry.

5

Claims

I claim:

1. A method of preparing a surface-pasteurized, low-fat, formed meat product that can be stored for an extended period of time comprising the steps of:

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(a) mechanically tenderizing a plurality of pieces of meat, said pieces each containing an exterior surface and an interior, such that multiple channels extending from the exterior surface to the interior are formed;

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(b) adding salt, phosphate, and water to the tenderized pieces of meat to form a mixture and massaging the mixture in a tumbling apparatus at a temperature in the range of about 0°C to about 15°C such that fat is transported through the channels and deposited on a wall of the tumbling apparatus and such that protein is exuded to form an adhesive layer on the exterior surface;

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(c) forming a plurality of massaged pieces of meat into a selected shape;

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(d) freezing the formed meat and subjecting the formed meat to portion control to result in frozen portions;

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(e) partially thawing the frozen portions to a depth of about 1 mm and treating the partially thawed portions at ultra-high temperature in the range of about 900°C and about 1200°C for a time sufficient to denature surface proteins, without burning, to a depth of not more than about 2 mm; and

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(f) freezing the ultra-high-temperature-treated portions and packaging them.

40

2. The method of claim 1 wherein the mixture of meat, salt, phosphate, and water is massaged for a sufficient time to reduce the fat content to not more than about 5% by weight.

5 3. The method of claim 2 further comprising adjusting the fat content of the massaged meat to a selected level in the range of about 5 to about 20% by weight by mixing fat particles with the massaged meat.

10 4. The method of claim 3 wherein the mixture further comprises a flavoring agent.

 5. The method of claim 3 wherein step (c) further comprises bonding said formed meat to a bone.

15 6. The method of claim 3 wherein the salt is a member selected from the group consisting of NaCl, KCl, MgCl₂, CaCl₂, and mixtures thereof, and the phosphate is a member selected from the group consisting of sodium, 20 potassium, and ammonium pyrophosphates; sodium, potassium and ammonium polyphosphates; sodium, potassium, and ammonium tripolyphosphates; trisodium, tripotassium, and triammonium phosphates; sodium, potassium, and ammonium hexametaphosphates; sodium, 25 potassium, and ammonium orthophosphates; and mixtures thereof.

 7. The method of claim 6 wherein the salt is a member selected from the group consisting of NaCl, KCl, 30 and mixtures thereof, and the phosphate is a member selected from the group consisting of tetrasodium pyrophosphate, acid sodium pyrophosphate, and glassy sodium polyphosphate.

35 8. The method of claim 7 wherein the salt, phosphate, and water are added in amounts such that the formed meat product comprises in the range of about 0.3 to about 0.6% salt, about 0.10 to about 0.19% phosphate, and about 70% to about 80% water, wherein all 40 percentages are by weight.

5 9. The method of claim 8 wherein the ultra-high temperature treatment is for a time in the range of about 5 to about 60 seconds.

10 10. The method of claim 9 wherein said surface proteins are denatured to a depth of not more than about 1 mm.

15 11. The method of claim 10 wherein the ultra-high temperature is in the range of about 1000 and about 1200°C.

20 12. The method of claim 11 wherein the ultra-high temperature treatment is at a temperature of about 1100°C for a time of about 30 seconds.

 13. The method of claim 12 further comprising marking the ultra-high temperature treated portions with grill marks.

25 14. The method of claim 13 wherein the salt, phosphate, and water are added in amounts such that the formed meat product comprises about 0.5% salt, about 0.15% phosphate, and about 75% water, wherein all percentages are by weight.

30 15. The method of claim 14 wherein said packaging step comprises packaging in a modified atmosphere comprising in the range of about 80% to about 100% carbon dioxide and about 0% to about 20% nitrogen gas.

35 16. The method of claim 15 wherein said modified atmosphere comprises about 80% carbon dioxide and about 20% nitrogen gas.

40 17. The method of claim 15 wherein said packaging is in a microwavable film.

5 18. The method of claim 15 wherein, in step (d),
said freezing precedes said subjecting the meat to
portion control.

10 19. The method of claim 15 wherein, in step (d),
said subjecting the meat to portion control precedes
said freezing.

20. A method of preparing a low-fat, formed meat
product comprising the steps of:

15 (a) mechanically tenderizing a plurality of pieces
of meat, said pieces each containing an exterior surface
and an interior, such that multiple channels extending
from the exterior surface to the interior are formed;

20 (b) adding salt, phosphate, and water to the
tenderized pieces of meat to form a mixture and
massaging the mixture in a tumbling apparatus at a
temperature in the range of about 0°C to about 15°C such
that fat is transported through the channels and
deposited on a wall of the tumbling apparatus and such
25 that protein is exuded to form an adhesive layer on the
exterior surface; and

 (c) forming the massaged pieces of meat together
into a selected shape.

30 21. The method of claim 20 wherein the mixture of
meat, salt, phosphate, and water is massaged for a
sufficient time to reduce the fat content to not more
than about 5% by weight.

35 22. The method of claim 21 further comprising
adjusting the fat content of the massaged meat to a
selected level in the range of about 5 to about 20% by
weight by mixing fat particles with the massaged meat.

40 23. The method of claim 22 wherein the mixture
further comprises a flavoring agent.

5 24. The method of claim 22 wherein step (c) further comprises bonding said formed meat to a bone.

10 25. The method of claim 22 wherein the salt is a member selected from the group consisting of NaCl, KCl, MgCl₂, CaCl₂, and mixtures thereof, and the phosphate is a member selected from the group consisting of sodium, potassium, and ammonium pyrophosphates; sodium, potassium and ammonium polyphosphates; sodium, potassium, and ammonium tripolyphosphates; trisodium, tripotassium, and triammonium phosphates; sodium, potassium, and ammonium hexametaphosphates; sodium, potassium, and ammonium orthophosphates; and mixtures thereof.

20 26. The method of claim 25 wherein the salt is a member selected from the group consisting of NaCl, KCl, and mixtures thereof, and the phosphate is a member selected from the group consisting of tetrasodium pyrophosphate, acid sodium pyrophosphate, and glassy sodium polyphosphate.

30 27. The method of claim 26 wherein the salt, phosphate, and water are added in amounts such that the formed meat product comprises in the range of about 0.3 to about 0.6% salt, about 0.10 to about 0.19% phosphate, and about 70% to about 80% water, wherein all percentages are by weight.

35 28. The method of claim 27 wherein the salt, phosphate, and water are added in amounts such that the formed meat product comprises about 0.5% salt, about 0.15% phosphate, and about 75% water, wherein all percentages are by weight.

40 29. The method of claim 28 further comprising the steps of

5 (d) freezing the formed meat and subjecting the formed meat to portion control to result in frozen portions; and

10 (e) partially thawing the frozen portions to a depth of about 1 mm and treating the partially thawed portions at ultra-high temperature in the range of about 900°C and about 1200°C for a time sufficient to denature surface proteins, without burning, to a depth of not more than about 2 mm.

15 30. The method of claim 29 wherein the ultra-high temperature treatment is for a time in the range of about 5 to about 60 seconds.

20 31. The method of claim 30 wherein said surface proteins are denatured to a depth of not more than about 1 mm.

25 32. The method of claim 31 wherein the ultra-high temperature is in the range of about 1000°C and about 1200°C.

30 33. The method of claim 32 wherein the ultra-high temperature treatment is at a temperature of about 1100°C for a time of about 30 seconds.

34. The method of claim 33 further comprising marking the ultra-high temperature treated portions with grill marks.

35 35. The method of claim 34 further comprising freezing the ultra-high-temperature-treated portions and packaging them in a modified atmosphere under reduced pressure.

40 36. The method of claim 35 wherein said modified atmosphere comprises in the range of about 80% to about

5 100% carbon dioxide and about 0% to about 20% nitrogen gas.

10 37. The method of claim 36 wherein said modified atmosphere comprises about 80% carbon dioxide and about 20% nitrogen gas.

38. The method of claim 36 wherein said packaging is in a microwavable film.

15 39. The method of claim 36 wherein, in step (d), said freezing precedes said subjecting the meat to portion control.

20 40. The method of claim 36 wherein, in step (d), said subjecting the meat to portion control precedes said freezing.

25 41. A surface-pasteurized, low-fat, formed meat product that can be stored for an extended period of time prepared by a process comprising the steps of:

(a) mechanically tenderizing a plurality of pieces of meat, said pieces each containing an exterior surface and an interior, such that multiple channels extending from the exterior surface to the interior are formed;

30 (b) adding salt, phosphate, and water to the tenderized pieces of meat to form a mixture and massaging the mixture in a tumbling apparatus at a temperature in the range of about 0°C to about 15°C such that fat is transported through the channels and deposited on a wall of the tumbling apparatus and such that protein is exuded to form an adhesive layer on the exterior surface;

35 (c) forming a plurality of massaged pieces of meat into a selected shape;

5 (d) freezing the formed meat and subjecting the formed meat to portion control to result in frozen portions;

(e) partially thawing the frozen portions to a depth of about 1 mm and treating the partially thawed portions at ultra-high temperature in the range of about 900°C and about 1200°C for a time sufficient to denature surface proteins, without burning, to a depth of not more than about 2 mm; and

10 (f) freezing the ultra-high-temperature-treated portions and packaging them.

42. The surface-pasteurized, low-fat, formed meat product of claim 41 wherein the mixture of meat, salt, phosphate, and water is massaged for a sufficient time to reduce the fat content to not more than about 5% by weight.

43. The surface-pasteurized, low-fat, formed meat product of claim 42 wherein the process further comprises adjusting the fat content of the massaged meat to a selected level in the range of about 5 to about 20% by weight by mixing fat particles with the massaged meat.

30 44. The surface-pasteurized, low-fat, formed meat product of claim 43 wherein the mixture further comprises a flavoring agent.

45. The surface-pasteurized, low-fat, formed meat product of claim 43 wherein step (c) further comprises bonding said formed meat to a bone.

46. The surface-pasteurized, low-fat, formed meat product of claim 43 wherein the salt is a member selected from the group consisting of NaCl, KCl, MgCl₂, CaCl₂, and mixtures thereof, and the phosphate is a

5 member selected from the group consisting of sodium,
potassium, and ammonium pyrophosphates; sodium,
potassium and ammonium polyphosphates; sodium,
potassium, and ammonium tripolyphosphates; trisodium,
tripotassium, and triammonium phosphates; sodium,
10 potassium, and ammonium hexametaphosphates; sodium,
potassium, and ammonium orthophosphates; and mixtures
thereof.

15 47. The surface-pasteurized, low-fat, formed meat
product of claim 46 wherein the salt is a member
selected from the group consisting of NaCl, KCl, and
mixtures thereof, and the phosphate is a member selected
from the group consisting of tetrasodium pyrophosphate,
acid sodium pyrophosphate, and glassy sodium
20 polyphosphate.

25 48. The surface-pasteurized, low-fat, formed meat
product of claim 47 wherein the salt, phosphate, and
water are added in amounts such that the formed meat
product comprises in the range of about 0.3 to about
0.6% salt, about 0.10 to about 0.19% phosphate, and
about 70% to about 80% water, wherein all percentages
are by weight.

30 49. The surface-pasteurized, low-fat, formed meat
product of claim 48 wherein the ultra-high temperature
treatment is for a time in the range of about 5 to about
60 seconds.

35 50. The surface-pasteurized, low-fat, formed meat
product of claim 49 wherein said surface proteins are
denatured to a depth of not more than about 1 mm.

40 51. The surface-pasteurized, low-fat, formed meat
product of claim 50 wherein the ultra-high temperature
is in the range of about 1000 and about 1200°C.

5 52. The surface-pasteurized, low-fat, formed meat product of claim 51 wherein the ultra-high temperature treatment is at a temperature of about 1100°C for a time of about 30 seconds.

10 53. The surface-pasteurized, low-fat, formed meat product of claim 52 further comprising marking the ultra-high temperature treated portions with grill marks.

15 54. The surface-pasteurized, low-fat, formed meat product of claim 53 wherein the salt, phosphate, and water are added in amounts such that the formed meat product comprises about 0.5% salt, about 0.15% phosphate, and about 75% water, wherein all percentages
20 are by weight.

 55. The surface-pasteurized, low-fat, formed meat product of claim 54 wherein said packaging step comprises packaging in a modified atmosphere comprising
25 in the range of about 80% to about 100% carbon dioxide and about 0% to about 20% nitrogen gas.

 56. The surface-pasteurized, low-fat, formed meat product of claim 55 wherein said modified atmosphere
30 comprises about 80% carbon dioxide and about 20% nitrogen gas.

 57. The surface-pasteurized, low-fat, formed meat product of claim 55 wherein said packaging is in a
35 microwavable film.

 58. The surface-pasteurized, low-fat, formed meat product of claim 55 wherein, in step (d), said freezing precedes said subjecting the meat to portion control.
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- 5 59. The surface-pasteurized, low-fat, formed meat product of claim 55 wherein, in step (d), said subjecting the meat to portion control precedes said freezing.

INTERNATIONAL SEARCH REPORT

International application No.

US95/16734

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : A23B 4/00; A23L 3/00

US CL : 426/521, 290, 518, 519, 524

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/521, 520, 290, 392, 393, 410, 518, 519, 641, 524

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A, 3,285,752 (HANSEN ET AL) 15 November 1966.	1-59

☐

Further documents are listed in the continuation of Box C.

☐

See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means	
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Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

GEORGE C. YEUNG

Telephone No. (703) 368-3848

